



Course Title: Artificial Intelligence

Sheet #8

CSP TIME MANAGEMENT

Two of our teaching assistants (TAs), Ahmed and Noha, are making their schedules for a busy morning. There are five tasks to be carried out:

- (F) Pick up food for the group's research seminar, which, sadly, takes one precious hour.
- (H) Prepare homework questions, which takes 2 consecutive hours.
- (P) Prepare the PR2 (robot that Noha uses for research) for a group of preschoolers' visit, which takes one hour.
- (S) Lead the research seminar, which takes one hour.
- (T) Teach the preschoolers about the PR2 robot, which takes 2 consecutive hours.

The schedule consists of one-hour slots: 8am-9am, 9am-10am, 10am-11am, 11am-12pm.

The requirements for the schedule are as follows:

- a. In any given time slot each TA can do at most one task (F, H, P, S, T).
- b. The PR2 preparation (P) should happen before teaching the preschoolers (T).
- c. The food should be picked up (F) before the seminar (S).
- d. The seminar (S) should be finished by 10am.
- e. Ahmed is going to deal with food pick up (F) since he has a car.
- f. The TA not leading the seminar (S) should still attend, and hence cannot perform another task (F, T, P, H) during the seminar.
- g. The seminar (S) leader does not teach the preschoolers (T).
- h. The TA who teaches the preschoolers (T) must also prepare the PR2 robot (P).
- i. Preparing homework questions (H) takes 2 consecutive hours, and hence should start at or before 10am.
- j. Teaching the preschoolers (T) takes 2 consecutive hours, and hence should start at or before 10am.

Answer the following questions:

1. What is the size of the state space for this CSP?
2. Which of the statements above include unary constraints?
3. Check all remaining values after enforcing all unary constraints.

F	H	P	S	T
<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1
<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2
<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3
<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4
<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1
<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2
<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3
<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4

4. Start from the table above, select the variable S and assign the value A2 to it. Check all remaining values below after performing forward checking.

F	H	P	S	T
<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1	<input type="checkbox"/> A1
<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2
<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3
<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4
<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1
<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2
<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3
<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4

5. Based on the result of 4, what variable will we choose to assign next based on the MRV heuristic (breaking ties alphabetically)?
6. Assign the first possible value to the variable chosen in 5, then perform forward checking. Check all remaining values left below.

<u>F</u>	<u>H</u>	<u>P</u>	<u>S</u>	<u>T</u>
<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1
<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2
<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3
<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4
<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1
<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2
<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3
<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4

7. We return to the result from enforcing just the unary constraints, which we did in 3. Select the variable S and assign the value A2. Enforce arc consistency, then check all remaining values below.

<u>F</u>	<u>H</u>	<u>P</u>	<u>S</u>	<u>T</u>
<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1 ●	<input type="checkbox"/> A1
<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2	<input type="checkbox"/> A2
<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3	<input type="checkbox"/> A3
<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4	<input type="checkbox"/> A4
<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1	<input type="checkbox"/> P1
<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2	<input type="checkbox"/> P2
<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3	<input type="checkbox"/> P3
<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4	<input type="checkbox"/> P4

8. Compare your answers from 6 and 7. Which of the following statements explains the difference between the two sets of domains?
 - a) Forward checking removes more values than arc consistency because forward checking checks consistency between any pair of variables, while arc consistency only checks relationships between pairs of assigned and unassigned variables.
 - b) Arc consistency removes more values than forward checking because arc consistency checks consistency between any pair of variables, while forward checking only checks relationships between pairs of assigned and unassigned variables.

Best wishes
Dr. Sherin El Gokhy